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ELIHU THOMSON[1]

ELIHU THOMSON'S INTEREST IN RESEARCH

To treat this subject comprehensively would be to write a complete biography of Professor Thomson, for research, both in its broadest sense of a search for knowledge and in its narrower sense of systematic experimentation, was the major interest of his life.

As a young boy we find him studying industrial processes, both mechanical and chemical. At the age of ten or eleven he was constructing small cupola furnaces and attempting to make iron castings. Prepared for high school two years before he reached the required age for entry, and urged to give up his books for a while, he weepingly protested that life would not be worth living if he had to discontinue his studies. He employed the two-year interval in school work in building static machines, Leyden jars, condensers, etc., and was continually making experiments, some of which, as he recognized later, were worthy of publication as original matter. Chemical knowledge he was simultaneously pursuing, through books and by experiment.

Throughout his high-school years he was always "constructing things," but it was after graduation, when at the age of seventeen, he became assistant professor and, two or three years later, full professor of chemistry, that his marvelously productive career as a scientist truly began. It was during this period from the age of seventeen to twenty-seven that he published his first original papers (on chemical subjects); experimented with electromagnetic waves, foreshadowing radio, and produced the first "tuned" circuit; accomplished telephone relaying; studied the fundamentals of dynamo-electric machines and established new and basic principles; suggested high voltage d-c transmission; advanced the novel but now accepted theory of relation between sun-spots, magnetic storms and auroras; studied hysteresis, and advanced precociously

[1] Papers presented at a meeting in commemoration of the life and work of Elihu Thomson under the auspices of the American Philosophical Society, the Franklin Institute of Pennsylvania, the Central High School of Philadelphia, the Massachusetts Institute of Technology and the General Electric Company, held in the halls of the American Philosophical Society and the Franklin Institute on February 16.

the electrical theory of matter; built and studied transformers, and experimented with electric energy distribution by their means; and somehow found leisure to construct a pipe organ and a microscope, fashioning all parts of these with his own hands. In later years he constructed with his own hands a telescope with 10-inch diameter objective, and used it constantly in astronomical studies.

When, in 1880, he gave up teaching, to devote himself to the commercial development of his ideas and to the building up of the great electrical industry which owes so much to him, he soon found that the urgent need for inventions and engineering design was engrossing nearly all his time, leaving small opportunity for scientific research. But he never lost his keen interest in science. In its literature he closely followed its progress, and often contributed to it by original suggestions.

To show the variety of his interests, I might mention the following diverse subjects which he studied and on which he contributed original papers: very high frequency currents, and their effects on the human body; x-rays, their diffusion, their effect on human tissue, their use in stereoscopic pictures; lightning hazards; aeroplanes; electric welding; the meteorite which fell in Canyon Diabolo, and the use of helium mixed with oxygen to prevent "bends" in caisson workers.

In 1899, as vice-president of the American Association for the Advancement of Science, he read a paper on "The Field of Experimental Research," and, the next year, took an active part in instituting the Research Laboratory of the General Electric Company. That laboratory was unique in industry in having for its primary purpose fundamental research. While the written record indicates that the laboratory was first proposed by E. W. Rice, Jr., then vice-president of the company, and while it was certainly founded by his authority, yet it is equally certain that Mr. Rice's keen interest in research in pure science arose from his long and close association with Professor Thomson, first as pupil and then as assistant. There can be no doubt but that Professor Thomson was the father of scientific research in the General Electric Company.

For years he was a most helpful and inspiring member of the advisory council of the laboratory, keenly interested in all details of its work and frequently helping by wise and timely suggestions. From his broad knowledge and experience he often could throw new light on our problems, and his resourcefulness seemed never-failing in suggesting methods of attack. To all of us in the laboratory his enthusiasm and keen mentality were always an inspiration. His wise counsel and hearty support were invaluable to us in the laboratory's early years.

In his later life, when he had relinquished all direct responsibility for engineering activities of the company, he was again able, in his Lynn laboratory, to return to his first and deepest interest—research. It was then that he did his classic work on fused quartz, producing a quartz mirror 60 inches in diameter for a telescope. A visit to him there was always delightful and stimulating. Always would he be found with some new experiment, new material or new idea, which he would eagerly discuss with his characteristic friendly smile and sparkling eyes. Even when failing health forbade active work, his old keen interest in science remained and stayed with him to the end.

A cultured gentleman, a lovely character, a great inventor, a most able engineer, he was also a gifted scientist, and truly the father of General Electric research.

W. D. COOLIDGE

RESEARCH LABORATORY OF THE
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ELIHU THOMSON THE SCIENTIST

NEARLY a decade ago, in reviewing Elihu Thomson's productive life, I wrote: "More than any man now living . . . Professor Thomson has combined in a most remarkable way the constructive power of the inventor, the thoroughness and soundness of the man of science, and the kindly balance of the ideal philosopher, teacher, and friend." Now that Professor Thomson is no longer with us, I still abide by that appraisal; and in again reviewing his contributions and characteristics, this time with emphasis on his talents as a scientist, I find added reasons to support this judgment.

There are scientists who dwell in ivory towers remote from the Rialto, and it is well that they do if it is there that they can be most productive; and there are scientists no less important to the world who elect to practice the scientific method for the realization of practical ends, and it is well that they do, for science must take its place in the workaday world.

The ivory tower scientist seeks primarily, we might say, to understand nature, while the applied scientist, whom we usually call an engineer, seeks to control nature. This distinction has been concisely stated by our distinguished colleague, Dr. Gano Dunn. "Engineering," says he, "is the art of the economic application of science to social purposes . . . the scientist . . . shuts his mind as far as possible to all human prejudice and influence of feeling, save only for the divine fire of that imagination which creates the working hypothesis; and he learns to discern truth and new knowledge in a study of the order of nature. The engineer, by the same intellectual processes as the scientist, applies that new knowledge to social service."

It was a notable characteristic of Professor Thomson that he embodied both these types of science in a

manner that makes it almost impossible to distinguish between them. He sought ardently to understand nature, and he was enormously successful in controlling nature. He possessed the divine fire of that imagination which creates the working hypothesis, and he applied knowledge engineeringwise to social purposes. Obviously, then, in discussing Thomson the scientist as distinct from Thomson the engineer, I make a circumscription of convenience, not of reality, a distinction that does an injustice to the unity of his outlook and achievement.

Who would venture to maintain, for example, that it was Thomson the inventor and electrical engineer and not Thomson the scientist who discovered the dynamical repulsion between a primary and a secondary coil? Since this discovery was used by him in developing the alternating current repulsion motor it certainly was a triumph in electrical engineering, but nevertheless it was a notable scientific achievement. This is likewise true of his investigation of the laws governing the electric arc, of his building the first high-frequency dynamo and the first high-frequency transformer and of his invention of electric resistance welding. Since Professor Thomson's inventive and engineering achievements are discussed by my colleague on this program, I merely call attention to much excellent scientific work as the accompaniment, and often the precursor, of his practical triumphs.

Within the amplitude of his activity, however, there were many examples of achievement and method bearing the hallmarks of fundamental, non-utilitarian science, such hallmarks as disinterested curiosity, reliance on experiment and intuitive grasp of scientific relationships. Let me recall several of these.

In 1875 Edison announced a new "etheric" force which he described as non-electrical. Professor Thomson, then only twenty-two years of age, doubted this, and, as he himself wrote:

> I had proposed to Houston that we carry on these experiments and show definitely that the so-called ''etheric'' force that Edison had announced in the papers was merely an electrical phenomenon. At this time I took upon myself the enlargement of the scale of the experiments, so as actually to obtain a very definite result. This was carried out, as follows, in 1875. A 6-inch spark Ruhmkorff coil was set up with one terminal connected by a wire about 5 feet long to a large tin vessel mounted on a glass jar on the lecture table. When the coil was in operation, sparks were allowed to jump across the terminals of the coil itself, these sparks being about 1½ inches to 2 inches long and having the character of condenser sparks. When the coil was in action, I explored the whole building throughout the several floors and then went up to the top of the building to the observatory, where Professor Snyder had charge of the astronomical instruments. It was found that tiny sparks could be obtained from metal objects wherever they were, in the cases or outside, from the door-knobs or from apparatus, by the simple expedient of shading from the light and detecting the tiny sparks with a pointed pencil by applying it, say, to the door-knob. I recognized clearly that this was a manifestation of electric waves passed through space, and I also understood that a system of communication might readily be based thereon.

With the exception of Joseph Henry's experiments, which were unpublished, here was the first experimental demonstration of the validity of Maxwell's theory, and here, too, was an example of Professor Thomson's extraordinary intuition anticipating the wireless transmission of signals twelve years before Hertz demonstrated electromagnetic waves and twenty odd years before Marconi received his patent on "telegraphy without wires."

This was one of the earliest experiments in a long series of investigations of high-frequency electrical phenomena. Only a year later in 1876, he discovered and was the first to use the method of tuning electric circuits, which is, of course, absolutely fundamental to modern communication systems. While working in this field he devised a way of producing high frequency alternating current from a direct current arc, by shunting the arc with inductance and capacity, thus discovering the method which played such an important role in wireless transmission until its virtual displacement by electronic tube devices. Because this method was actually applied to radio by Poulsen it is generally known as the Poulsen arc.

Among the many other results of his basic high-frequency discoveries is modern electrosurgery, which Dr. Harvey Cushing put into effective use.

This was but one of several contributions to medical science. After Röntgen announced his discovery of x-rays in 1895 Professor Thomson immediately began a series of experiments with them, the foundation for which had been laid by his previous experiments, beginning in 1891, on electric discharge through gases. In 1897 he made the first application of stereoscopic principles to x-rays, a great step forward in the medical use of x-rays for clinical purposes. He also made many improvements in the design of x-ray tubes, including the double-focus tube and a cooled-target tube. Along with these experiments he took a lively interest in the physiological effects of x-rays, going so far as to expose one of his fingers until a definite burn resulted.

In addition to electricity, two other branches of physics, optics and acoustics, commanded Professor Thomson's interest. In 1878 he published an account of a new method of grinding and polishing glass mirrors such as are used in telescopes. He later originated many ingenious tools for the working of optical glass,

and as a hobby built for his own home observatory a ten-inch achromatic telescope. This interest in optics was of course related to his life-long interest in astronomy. A bibliography of his astronomical studies and observations contains a score of items, including discussions of Aurora's "cosmical electricity," meteor flight, zodiacal light, comets and solar eclipses. Acoustics, like optics and astronomy, was a fruitful scientific hobby, and deserves mention as evidence of Professor Thomson's wide range of scientific activities. He even constructed a pipe organ, and played it with great pleasure. Another avocation pursued with scientific ardor was color photography.

Still other scientific byways of Professor Thomson's interest were the earth sciences. He published on "The Nature and Origin of Volcanic Heat," and in his last appearance before the American Academy of Arts and Sciences in 1933 he read a paper on "The Krakatoa Outbreak." The eruption of this volcano in Java occurred when he was a small boy in Philadelphia, and had incited the curiosity which he always exhibited. He had watched for evidences, in the brilliant sunsets, of the volcanic ash in the upper atmosphere and had, I am informed, recorded his observations. At a much later date he hired as a research assistant the sole survivor of the catastrophe and induced him to record his personal observations of the event. In his paper before the academy he reported on this record, upon the history of the eruption and upon his own boyhood observations of its effects.

While the major portion of Professor Thomson's scientific research was in the field of physics and he usually referred to himself as a physicist, he was an able chemist as well; in fact, he began his professional career as a teacher of chemistry in the Central High School in Philadelphia. In recently examining his contributions to chemistry, I found that *Chemical Abstracts* in the twenty-year period beginning in 1907 listed two dozen papers of his relating to chemistry. In the first year after his graduation he reported observations on color changes produced by heat in chemical compounds, and in 1873 he contributed to the *Philadelphia Medical Times* a paper on the "Inhalation of Nitrous Oxide, Nitrogen, Hydrogen and other Gases and Gaseous Mixtures," thus foreshadowing his suggestion forty-seven years later that helium-oxygen mixtures be used in deep-sea diving. He early observed the transformation of ordinary carbon into graphite, and in 1902 disclosed his pioneer work in fused quartz, a field in which he was again working at the end of his life. In the nineties he published three papers on the possibilities of liquid air, in 1906 an article with the modern-sounding title "Alcohol as a Motor Fuel," and in 1910 comments on the light of the firefly. In chemistry, as well as in physics, he demonstrated an intuitive insight into nature that testifies to his profound gifts as a scientist.

It is laboring the obvious to recite further Professor Thomson's scientific accomplishments. I turn, rather, to some of his more intangible achievements and to the scientific ideals which he exemplified.

Behind all his varied scientific activities, stood a man who had complete faith in the efficacy of the scientific method and who in all his activities, vocational and avocational, was the apotheosis of the scientific spirit. Something of his own view of his methods was incorporated in an address delivered by him in 1899 as vice-president and chairman of the physics section of the American Association for the Advancement of Science, in which he said:

> The development in the field of research by experiment is like the opening of a mine, which, as it deepens and widens, continually yields new treasure but with increased difficulty, except when a rich vein is struck and worked for a time. In general, however, as the work progresses there will be needed closer application and more refined methods. In most fields of research the investigator must be ready to guide the trained mechanic and be able himself to administer those finishing touches which often mark the difference between success and failure. There must be in his mental equipment that clear comprehension of the proper adjustment of means to ends which is of such great value in work in new fields. He must also learn to render available to science the resources of the larger workshops and industrial establishments. . . . Scientific facts are of little value in themselves. Their significance has a bearing upon other facts, enabling us to generalize and to discover principles, just as the accurate measurement of the position of a star may be without value in itself, but in relation to other similar measurements of other stars may become the means of discovering their proper motion. We refine our instruments, we render more trustworthy our means of observation, we extend our range of experimental inquiry and thus lay the foundation for future work with the full knowledge that although our researches can not extend beyond certain limits, the field itself is even within those limits inexhaustible.

Observation and experimental inquiry were his chief reliances; he apparently did not resort to the analytical methods that most scientists and engineers use who tackle problems as complex as he solved. Perhaps the answer lies in that intuition which I have mentioned; Professor Thomson did not need to employ mathematical analysis because his mind leapt to correct conclusions without it.

His powers of observation he carried into every walk of life, and no one could be with him for ten minutes without being impressed and stimulated by his perception and by his wide-ranging knowledge of natural phenomena. Perhaps he could best be described by saying that he was a brilliant natural philosopher who

was held in equally high esteem by practical engineers and by academic scientists.

Perhaps the most eloquent testimony to his scientific contributions may be found in the wide-spread appreciation to-day of the value of research in industry. Professor Thomson was one of the first in America to recognize the importance of research, both fundamental and practical, to our industrial progress. This was a contribution that transcended any of his scientific discoveries.

His sense of public responsibility is illustrated by his long reluctance to patent his system, developed in 1878, of distributing alternating current by transformers, because of the possible danger to the public. It was not until he discovered a way to avoid the danger, chiefly by grounding the secondary in the transformer, that he filed his patent in 1885. The patent on this safety device was dedicated to the public from a feeling that no patent or invention which has to do with public safety should in any way be restricted or made unavailable to the people.

That he cherished the title "Professor" was indication of his unabated interest in education. He never ceased to teach. "Throughout his life," wrote my predecessor and his friend, Dr. Richard C. Maclaurin, president of M.I.T. from 1909 to 1920, "he has not only done great things himself, but shown an intense desire to help all who are struggling earnestly with scientific problems. He has proved an inspiration to an ever-widening circle of engineers and others who have intrusted him with their secrets and sought his help in overcoming their difficulties. They have done this, knowing that they had only to ask in order to get the full benefit of his imagination and his power, and that they need have no misgivings that he would take any advantage of their confidence or any credit for their work, for he has no touch of selfishness."

From my own knowledge of Professor Thomson I can validate Dr. Maclaurin's tribute.

His long association with M. I. T. affords a specific example of his devotion to education. He became a lecturer in electrical engineering at this institution in 1894, and from then until his death he maintained with it the closest sort of relationship. He was elected a life member of the corporation in 1898, was acting president in 1920 to 1923, and for many years was a member of the executive committee of the corporation. His services to the institute alone place him among those who have contributed greatly to American science.

If we add to this his services to the Franklin Institute, to the American Philosophical Society, to the American Academy of Arts and Sciences, to the National Academy of Sciences and to a host of other institutions, we get some measure of his influence and constructive contributions to the scientific profession.

For these and many other reasons it is meet to pay tribute to Professor Thomson as a distinguished scientist, and I do so with affection and enthusiasm. Not only were his scientific contributions numerous and important, but he consistently served science by being an ideal connecting link between the practical and the theoretical, the industrial and the academic. By his vigor, perseverance and versatility he contributed one of the most brilliant chapters yet written in the book of American science.

Karl T. Compton

Massachusetts Institute of Technology

OBITUARY

WILLIAM McDOUGALL

With the death of William McDougall on November 28, 1938, the science of psychology lost one of its foremost creators. The range of his contributions prohibits detailed review here. Fortunately he himself has given an unusually penetrating interpretation of his life and work.[1]

The prolonged preparatory studies of McDougall foreshadow the wide scope of his later work. He was born in Lancashire on June 22, 1871. After a year at Weimar, he entered Manchester University (1886). Feeling forcibly the impact of the controversy over evolution, he read widely in biology and worked also in geology and paleontology. He won a scholarship at Cambridge and took the premedical course there, specializing in physiology, anatomy, anthropology (1890–94). Drawn toward problems of the nervous system, he completed the medical course at St. Thomas Hospital, London, ending as house physician (1894–98).

In reading William James he had become increasingly aware of the possibilities of the psychological approach to the problems of human nature. During the next two years he came into first-hand contact with primitive cultures (participation in the Cambridge Anthropological Expedition to the Torres Straits; collaboration in Borneo with C. Hose); and studied the newer laboratory methods of German experimental psychology (with G. E. Müller at Göttingen). To this extensive background was later added four years of study and treatment of "shell-shocked" soldiers.

The external features of McDougall's professional career did not bear a very intimate relation to his creative work, and may be stated briefly: At first,

[1] "A History of Psychology in Autobiography," I. Edited by C. Murchison. Worcester: Clark University Press, 1930, pp. 191–223.

reader in experimental psychology at University College, London (1900–04); later Wilde reader in mental philosophy at Oxford (1904–20); during the war, major in the Royal Army Medical Corps; then professor of psychology at Harvard (1920–27); finally professor and head of the department of psychology at Duke University (1927–38). His academic degrees and honors include the following: Cambridge University, M.B., and Fellow, St. John's College (1898); Oxford University, A.M. (1908), and Fellow, Corpus Christi College (1912); University of Manchester, Honorary Sc.D. (1919); Fellow, Royal Society of London (1912); Honorary Fellow, St. John's College, Cambridge (1938).

McDougall's psychological activity was of a varied character formally: he was systematist, acute empirical observer, clinician, experimentalist. In addition to his intensive early experiments in the psychophysiology of vision, he has published experimental work on auditory perception, memory, mental fatigue, drug effects, animal behavior, evolutionary theory. Unfortunately, most of the voluminous clinical notes made during the four years of war work with shell-shocked soldiers remain unpublished.

Although occupied at first more with their physiological correlations and later with their social aspects, McDougall attempted from the beginning to develop a system of concepts in terms of which the whole range of mental events might be interrelated. Accepting as fundamental the directed, purposive features of behavior and their evolutionary development, he developed a biological conception of fundamental urge systems. Behavior in all its complexities was interpreted as an expression of their action and conflict at different levels of organization. This conception was differentiated in its detailed application to problems in the fields of animal and human behavior, normal, abnormal, primitive, social.

McDougall was the most fundamentally biological of all psychologists, and his stress on heredity and eugenics bore major experimental fruit. Typical of his views as to the possible contributions of psychology to biology was his sustained experimental test, during the last seventeen years of his life, of the Lamarckian theory. For, if substantiated, it would provide an essentially psychological explanation of the dynamics of the evolutionary process itself. Significant also was his elaboration of the implications of psychology for the related social sciences and for philosophy.[2]

In this country McDougall, the man, was unfortunately known well by relatively few of his fellow psychologists. His deep family attachments are revealed in his own writings. To each of his departmental colleagues he was a personal friend, and his department was run intellectually and administratively in a spirit of absolute democracy. Characteristic to the end were his vigor, keenness, flexibility, open-mindedness. Always bold in his thinking and insatiably curious concerning every type of mental phenomenon, he believed that study at the fringes of psychology (as in psychic research) would yield valuable further insights into human nature. His great courage and strength of character were brought into relief during his last months. Very weak, and suffering from a painful cancer, he wrote the final chapter of his last book lying on his back, and, until physically unable, walked to the laboratory to run final control trials in his Lamarckian experiment.

An evaluation of McDougall's psychology in relation to current trends would be premature. Similar answers to many of the problems he discussed are being approximated by others, though often in other terms. His own terminology seems not to have readily suggested functional tests for its own further refinement. Any scientist must be viewed against the contemporary background of his own science. So considered, McDougall was unique in breadth of view and variety of contribution. During a period of psychology characterized by perhaps premature specialization and a tendency to turn toward the problems of other fields, McDougall performed the great service of facing steadily the vast range of phenomena which in the broadest sense are the concern of the *psychologist,* of pointing in masterful fashion to their essential features and of showing how in terms of his comprehensive set of concepts, their interrelationship might, to a first approximation, be understood. When highly satisfactory answers to all the problems with which he wrestled have been finally formulated psychology will have become a science indeed, and the goal of a great mind achieved.

Karl Zener

Duke University

RECENT DEATHS AND MEMORIALS

Admiral Ralph Earle, U.S.N., retired, president of Worcester Polytechnic Institute since 1925, died suddenly on February 13 at the age of sixty-five years.

Frank Dean Tubbs, who was professor of geology at Bates College, Lewiston, Me., from 1907 to 1929, died on February 23 at the age of seventy-four years.

A cable from Bermuda to *The New York Times* dated February 21 reports that on February 20 Dr. Alfred George Jacques, of the Rockefeller Institute for Medical Research, was drowned, and Dr. Marie Lebour, of the Marine Biological Laboratory at Plymouth, England, had a narrow escape when the dinghy in which they were dredging for specimens

[2] A bibliography of McDougall's work, appearing in *Character and Personality,* March, 1939, lists 147 titles of articles and books.

upset. Dr. Jacques, who was in his forty-third year, was unable to swim. Dr. Lebour, who is now seventy years old, was able to keep afloat until rescued.

THE death is announced of Professor S. P. L. Sörensen, director of the chemical department of the Carlsberg Laboratory at the University of Copenhagen, at the age of seventy-one years.

PROFESSOR KARL SCHRÖTER, emeritus professor of botany in the Federal College of Technology, Zurich, has died at the age of eighty-four years.

IT is stated in *Nature* that the British Minister of Health has approved an order made by Slough Town Council under the Town and Country Planning Act, 1932, for the preservation of Observatory House, Slough, the residence of Sir William Herschel, where he set up his 40-ft. telescope, and also of his son, Sir John Herschel.

A CEREMONY in commemoration of the biologist and physician, Lazzaro Spallanzani (1729–1799) will be held at Padua next spring during the meeting of the International Congress of Experimental Biology.

SCIENTIFIC EVENTS

THE PUBLIC WORKS ADMINISTRATION AND THE NATIONAL PARK SERVICE

WORK on the eighty-nine PWA projects for physical improvements in the national parks and monuments, from PWA allotments amounting to $2,090,500, which were announced in 1938, was under way before January 1. Ranging from allotments for $500 to $230,000 for one project, most of the work involves improvements to utilities, including sanitation facilities, water systems, lighting and power plants in the various areas of the Federal park system. In Yosemite National Park, California, there are ten miscellaneous projects that will be carried out at a cost of $200,600.

At Lassen Volcanic National Park, California, five projects are in progress involving a total expenditure of $76,500. One at Carlsbad Caverns, New Mexico, involves the installation of modern plumbing facilities in the caverns, 750 feet below the surface. This entails pumping raw sewage to the surface, requiring a special type pump—a problem seldom experienced by sanitary engineers.

At Lava Beds National Monument, California, a well will be drilled 900 feet through a lava cap in an effort to find water. The water has now to be hauled some distance in tanks and barrels. At Petrified Forest National Monument, Arizona, a pump house and new pipe line will be installed to increase its fresh water supply obtained from a well at "Pig River" twelve miles away. A well drilled at Petrified Forest several years ago produced only salt water.

Some of the larger projects undertaken in the national parks and monuments are:

At Grand Canyon National Park, Arizona, a schoolhouse and teacher's residence together with schoolroom equipment, to cost $35,000; Giant Forest, in Sequoia National Park, California, an improved water system to cost $36,000; modern water and sewage systems at Rocky Mountain National Park, Colorado, $42,000; an extension to the storage reservoir at Mesa Verde National Park, Colorado, $35,000.

Boulder Dam Recreational Area, Nevada, will have increased facilities at the Hemenway Wash area being developed on the shore of Lake Mead. These will include water, sewage, electricity and an irrigation system. This project will cost $150,000.

Olympic National Park, Washington, will get an administration building, custodian's home, warehouse and garage on land donated to the Federal Government by the city of Port Angeles, Washington. A new fire lookout tower, fire patrol cabins and trailside shelters will be provided. The projects for this park will cost $90,000, with an additional $25,000 for the extension and reconstruction of the telephone and radio systems, and $90,500 for miscellaneous trail construction.

In Yellowstone National Park, Wyoming, $230,000 will be spent for improvement and extension of the water, sewage and electric systems for Old Faithful, West Thumb, Fishing Bridge and Canyon. An additional $12,500 are expected to go on five secondary fire lookouts.

An allotment of $45,000 for the Statue of Liberty National Monument, New York, will permit the replacing of an old six-inch water main from the tip of Manhattan Island to Bedloe's Island.

Most of the other projects involve relatively small sums, and have to do with sewage, water, sanitary facilities and similar improvements. The Salem Maritime National Historic Site, Massachusetts, will have its separate and inadequate heating plants replaced by a new central plant in the old custom house, to serve Derby House and Hawkes House.

THE DEDICATION OF THE McDONALD OBSERVATORY

THE ceremonies attending the dedication of the McDonald Observatory at Fort Davis, Texas, to be held from May 5 to 8, will be conducted jointly by the University of Chicago and the University of Texas. On this occasion an astronomical symposium will be held under the auspices of the observatory and of the Warner and Swasey Company, under the general title "Galactic and Extragalactic Structure." Those wishing to attend the dedication and the symposium are

requested to make hotel reservations by writing to the Observatory, Fort Davis, Texas.

The Southwestern Division of the American Association for the Advancement of Science will hold its annual meeting at Alpine, Texas, from May 2 to 5, immediately preceding the dedication ceremony. On Thursday evening, May 4, Professor Arthur H. Compton will deliver the annual John Wesley Powell Lecture of the Southwestern Division on "Physics Views the Future." On Thursday morning and afternoon the sessions of the Section on Physical Sciences will be reserved for astronomical papers. Contributions to this program are invited from all observatories. Titles should be sent to Dr. C. T. Elvey, McDonald Observatory, Fort Davis, Texas, before April 1.

On Friday morning there will be an astronomical symposium at the McDonald Observatory at which the presiding officer will be Professor Henry Norris Russell, director of the Princeton University Observatory. The speakers will be Professor Harlow Shapley, of the Harvard College Observatory; Dr. J. Gallo, of the National Observatory of Mexico, and Dr. J. S. Plaskett, director emeritus of the Dominion Astrophysical Observatory.

The program at the dedication on Friday afternoon of the McDonald Observatory will be as follows:

Tender of completed observatory to the director by President P. E. Bliss, of the Warner and Swasey Company.

Acceptance of the completed observatory by Professor Otto Struve, Yerkes Observatory.

"The Cooperative Enterprise," President Robert Maynard Hutchins, of the University of Chicago.

Acceptance for the University of Texas by a member of the Board of Regents.

"Some Features of the New Mirror," Dr. J. S. Plaskett, director emeritus of the Dominion Astrophysical Observatory.

"The First of the Sciences," Professor Arthur H. Compton, University of Chicago.

Dedication of the observatory, President J. W. Calhoun, of the University of Texas.

On Saturday there will be a symposium on "Galactic Structure." In the morning Professor S. A. Mitchell, of the McCormick Observatory, will preside, and Dr. J. H. Oort, of the Leiden Observatory, and Dr. R. J. Trumpler, of the University of California, will take part. In the afternoon the presiding officer will be Professor H. G. Gale, of the University of Chicago, and the speakers will be Dr. Otto Struve, of the Yerkes Observatory; Dr. Bart J. Bok, of the Harvard College Observatory; Dr. C. T. Elvey, of the McDonald Observatory, and Dr. G. P. Kuiper, of the Yerkes Observatory. Dr. E. A. Milne, of the University of Oxford, will speak on "Cosmological Theories" at the evening session, over which Dr. Edwin Hubble, of the Mount Wilson Observatory, will preside.

A further symposium on "Galactic and Extragalactic Structure" will he held on Sunday presided over in the morning by Professor E. F. Carpenter, of the Steward Observatory, with Dr. Walter Baade, of the Mount Wilson Observatory, and Professor Harlow Shapley, of the Harvard College Observatory, as speakers. In the afternoon Dr. W. S. Adams, of the Mount Wilson Observatory; Dr. Cecilia Payne Gaposchkin, of the Harvard College Observatory; Dr. W. W. Morgan, Yerkes Observatory; Dr. Bertil Lindblad, Stockholm Observatory and Morrison research associate at the Lick Observatory, and Dr. S. Chandrasekhar, of the Yerkes Observatory, will take part in the discussion. In the evening Dr. Arthur H. Compton, of the University of Chicago, will preside, and Dr. Edwin Hubble, the Mount Wilson Observatory, will be the speaker. In the final session on Monday morning Dr. W. H. Wright, of the Lick Observatory, will be the presiding officer, and the speakers will be Dr. Joel Stebbins, of Washburn Observatory, and Professor Henry Norris Russell, of Princeton University Observatory.

AWARD OF THE HILLEBRAND PRIZE OF THE CHEMICAL SOCIETY OF WASHINGTON

THE Hillebrand Prize of the Chemical Society of Washington, for 1938, has been awarded to Raleigh Gilchrist and Edward Wichers, of the National Bureau of Standards, for their paper entitled "A New System of Analytical Chemistry for the Platinum Metals," presented before the ninth International Congress of Pure and Applied Chemistry at Madrid.

The work represents the first general advance in the analytical chemistry of the platinum group since Deville and Stas devised methods for the analysis of the platinum alloys used in fabricating the international prototype meter and kilogram, over sixty years ago. The new system enables the chemist to separate and determine these six closely related metals with a degree of accuracy equal to that of the more exact procedures used for the common metals.

Related procedures applied to refining have resulted in the preparation of the platinum metals in an exceptionally high degree of purity. These pure metals and some of their alloys are used to establish certain important standards based on natural constants, such as freezing points in the upper range of the temperature scale, standards of radiation, of electrical resistance and of thermal electromotive force.

The prize will be awarded at the annual dinner of the society, which will be held at the Cosmos Club on March 9.

AWARD OF THE WILLARD GIBBS MEDAL TO DR. VAN SLYKE

The Willard Gibbs Medal of the Chicago Section of the American Chemical Society has been awarded for 1939 to Dr. Donald Dexter Van Slyke, research chemist of the Rockefeller Institute for Medical Research, New York City, in recognition of his work on the chemistry of proteins, enzyme action blood chemistry and the metabolic conditions of diabetes and nephritis. In announcing the award the jury gave the following summary of the work for which it was made:

By showing that fatal diabetic coma is preceded by a falling off in the bicarbonate content of blood plasma, Dr. Van Slyke made it possible to anticipate and prevent the sudden onset of coma. Such bicarbonate determination is now in general application in hospitals.

In Bright's disease and renal physiology, he has worked out methods of measurement of renal function, established the relation of renal function to renal disease, and found some explanation for chemical changes in the blood and in metabolism.

The mystery surrounding the mechanism of enzyme action he solved by showing that enzymes act by forming with substrates the substances acted upon by enzymes, definite compounds in which the substrate becomes unstable and undergoes decomposition. In the physical chemistry of gases and electrolytes of the blood he showed the law governing the solubility of the blood gases—oxygen, carbon dioxide, nitrogen, carbon monoxide and hydrogen—in blood fluid and cells.

In the physiology of amino acids, Dr. Van Slyke has followed through the animal body the course of such acids from digesting proteins, proving that they pass into the blood and thence into all tissues, but chiefly into the liver, and that the change to urea nitrogen occurs chiefly in the liver.

In the chemistry of amino acids he has developed methods for quantitative separation, methods for determining aliphatic primary amino nitrogen and analysis which have become standard, and analysis of proteins by determining the characteristic chemical groups of amino acids resulting from hydrolysis.

The speed and accuracy of gasometric micro methods of analysis worked out by Dr. Van Slyke have led to their introduction into general analytical microchemistry. These methods are in routine use for ammonia, organic nitrogen, organic carbon, calcium, iodate, chloride, ferricyanide and reducing sugars.

Determination of proteins combined with alkali in the cells and in the fluid of the blood showed that the differences in non-diffusible protein ions combined with alkali within and without the cells were such as to clear up, under the Gibbs-Donnan theory for heterogeneous equilibria, the puzzling situation which arose from the fact that the concentration of certain chemicals is not the same in blood fluid and blood cells. These differences were found to vary regularly with increasing pH and with increasing oxygenation of the hemoglobin.

Dr. Van Slyke introduced a unit now generally adopted for expressing quantitatively the power of "buffers," substances which can loosely combine with alkali and surrender it to strong acids, to set free in their place only acids that are relatively weak and innocuous. By this unit, the activity of the buffer solution is related to pH and the dissociation constant of the buffer acid or base.

The award was determined by a national jury of scientific men, of which Professor Charles D. Hurd, of Northwestern University, was chairman. Dr. Robert R. Williams, of New York, discoverer of the chemical structure of vitamin B, was the medalist in 1938. Other medalists were: Svante Arrhenius, of Sweden; Mme. Marie Curie, of France; Sir James Irvine, of Scotland; Dr. Richard Willstaetter, of Munich. Among American scientific men have been Theodore W. Richards, Leo H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, Edward W. Morley, William H. Burton, William A. Noyes, F. G. Cottrell, Julius Stieglitz, Gilbert N. Lewis, Moses Gomberg, John Jacob Abel, William D. Harkins, Claude S. Hudson, Irving Langmuir, Phoebus A. Levene, Edward C. Franklin, Harold C. Urey, Charles A. Kraus, Roger Adams and Herbert N. McCoy.

SCIENTIFIC NOTES AND NEWS

Daniel W. Mead, consulting engineer of New York City, a former president of the American Society of Civil Engineers, was presented with the Washington Award for 1939 of the Western Society of Engineers at a dinner held in Chicago on February 20.

Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, has been elected an honorary member of the Sociedád Cubana de Historia Natural Felipe Poey.

Dr. Frank Schlesinger, director of the Observatory of Yale University, has been elected a member of the Royal Society of Sciences of Upsala.

Dr. Alfred Harker, fellow of St. John's College and reader in petrology emeritus in the University of Cambridge, celebrated his eightieth birthday on February 9.

Sir Henry Hallett Dale, director of the National Institute for Medical Research, and Dr. Arthur Lyon Bowley, emeritus professor of statistics in the University of London, have been elected honorary fellows of Trinity College, Cambridge.

The University of Oxford will confer the degree of doctor of science on Dr. Pio del Rio Hortega, director of the National Institute of Cancer and of the Lab-

oratory of Normal and pathological Histology in Madrid, in recognition of his "valuable discoveries, arising out of the employment of new and original methods in connection with the anatomy of the brain."

THE British Institution of Chemical Engineers has awarded the Osborne Reynolds Medal, presented annually in commemoration of Professor Osborne Reynolds, to Hugh Beaver for "valuable constructive work." The Moulton Medal, presented annually in commemoration of Lord Moulton, director-general of Explosives Supply in the Ministry of Munitions during the war, has been awarded jointly to Dr. J. H. Dobson and Dr. W. J. Walker, professor of engineering in the University of the Witwatersrand, Johannesburg, for their work on engineering problems associated with the improvement of conditions in mines. The Junior Moulton Medal has been awarded to E. F. J. Tomalin, who has recently left King's College, London, for the Dutch West Indies to work in the petroleum industry, and the William Macnab Medal to Pierre Etienne Rousseau, of Johannesburg, a mining engineer.

IT is announced in *Nature* that the Academy of Sciences in Vienna has made the following awards: The Haitinger prize for physics to Dr. H. Haberlandt, for his work on the luminescence of fluorites and other minerals; the Rudolf Wegscheider prize for chemistry to Dr. R. Kuhn, for his work on lactoflavine; the Fritz Pregl prize for microchemistry to Dr. F. Hecht, for his work on microchemical analysis, particularly of thorium, monazite and uranium minerals; the Hansgirg prize for astronomy to Dr. M. Beyer, for his work on the photometry of stars, and in particular for his work on variable stars.

F. MALCOLM FARMER, vice-president and chief engineer of the Electrical Testing Laboratories, New York City, has been nominated for the presidency of the American Institute of Electrical Engineers.

DR. F. G. DONNAN, professor of chemistry in the University of London, has been elected to succeed Sir F. Gowland Hopkins as president of the Association of Scientific Workers.

OFFICERS of the Royal Astronomical Society, London, have been elected as follows: *President,* Professor H. C. Plummer; *Vice-presidents,* Professor S. Chapman, W. M. H. Greaves, Dr. H. Spencer Jones and Professor F. J. M. Stratton; *Treasurer,* J. H. Reynolds; *Secretaries,* Professor H. H. Plaskett and D. H. Sadler; *Foreign Secretary,* Sir Arthur Eddington.

SIR JAMES JEANS, the mathematical physicist, who was professor of applied mathematics at Princeton University from 1905 to 1909, has accepted an invitation to become the Conservative candidate for Parliament from the University of Cambridge at the next general election.

DR. HERBERT S. JENNINGS, of the Johns Hopkins University, has been appointed professor of zoology for the spring semester at the University of California at Los Angeles.

PROFESSOR OTTO NEUGEBAUER, of the University of Copenhagen, has accepted an appointment as professor of mathematics at Brown University, where he will be engaged in research until May. During the summer he will lecture in England, and will return to Providence in September.

DR. JAMES COULL, professor of chemical engineering of Cooper Union, New York City, a native of Aberdeen, Scotland, has been appointed professor and head of the department of chemical engineering at the University of Pittsburgh, to succeed Professor Harrison C. Bashioum, who died last October. He will take up the work at once.

E. H. PRAEGER, of New York City, for the last several years chief engineer for Madigan-Hyland, consulting engineers for Park Commissioner Robert Moses of New York, has been named head of the department of civil engineering at the Rensselaer Polytechnic Institute. He succeeds Professor Thomas R. Lawson, who will retire at the end of the year after serving for forty years as a member of the faculty, as head of the department since 1921.

DR. RICHARD PRAGER, of Potsdam, Germany, until recently of the University of Berlin, arrived in Boston on February 26 to join the research staff of the Harvard College Observatory. He will be at Harvard for at least two years, taking up research work on variable stars. Dr. Prager, who was stationed until recently at the Berlin-Babelsberg Observatory, is known as bibliographer in the field of variable stars and for many years was chiefly responsible for naming variable stars and for recording them in the annual catalogue.

DR. JAMES RÖGNVALD LEARMONTH, Regius professor of surgery at the University of Aberdeen, has been appointed professor of surgery at Edinburgh University to succeed the late Sir David Wilkie.

DR. L. WITTGENSTEIN, formerly fellow of Trinity College, has been elected professor of philosophy at the University of Cambridge, to succeed Dr. G. E. Moore, who will retire at the end of the current academic year.

DR. FRANK H. JOHNSON, instructor in biology at Princeton University, has been awarded a fellowship by the Rockefeller Foundation in order to carry on work in microbiology in the laboratory of Professor A. J. Kluyver, at the Technische Hoogeschool, Delft,

Holland. Dr. Johnson will spend six months in Professor Kluyver's laboratory, returning to Princeton next autumn.

DR. BENEDICT CASSEN has joined the staff of the Westinghouse Research Laboratories in East Pittsburgh, Pennsylvania, to conduct research on means of producing high voltage x-rays for therapeutic uses. He has been engaged in x-ray and neutron research at the Harper Memorial Hospital in Detroit.

DR. ALBERT RAY OLPIN has been appointed to succeed the late Hurlbut S. Jacoby as research director of the Ohio State University Research Foundation.

JAMES STOKLEY, associate director in charge of astronomy in the Franklin Institute of Philadelphia, has been appointed director of the new Buhl Planetarium and Institute of Popular Science in Pittsburgh. The Board of Managers of the Franklin Institute has accepted his resignation, effective on April 15. The Buhl Institute is being erected by the Buhl Foundation, at a cost of $1,070,000. The building, now nearing completion, is situated on the north side of the city on a site furnished by the municipality, which was formerly occupied by the old Allegheny City Hall. In addition to a Zeiss planetarium, fifth in the United States, and a public observatory, the building will include a lecture hall seating 250 persons, a main exhibit hall 150 feet long by 33 feet wide, five smaller halls, a room for amateur telescope makers, offices, shops and preparation rooms.

DR. WARREN J. MEAD, head of the department of geology of the Massachusetts Institute of Technology, delivered the February lecture before the Rensselaer Chapter of the Society of Sigma Xi. The March lecture will be delivered by Dr. Brian O'Brien, of the University of Rochester. His subject will be "Detection and Consequences of the Variability of the Sun."

PROFESSOR A. K. LOBECK, of the department of geology of Columbia University, recently returned from a tour of several southern universities, where he gave lectures on Russia, including one before the LeConte Scientific Society of the University of South Carolina.

DR. FRANCIS CARTER WOOD, director of the Institute of Cancer Research at Columbia University, gave the Bergen lecture at Yale University on February 1. He spoke on "Cancer—Social and Scientific Aspects."

APPLICATIONS for the positions of senior mineral economist, at $4,600 a year; mineral economist, at $3,800 a year; associate mineral economist, at $3,200 a year, and assistant mineral economist, at $2,600 a year, must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than March 13. Competitors will not be required to report for examination at any place, but will be rated on the extent of their education and on the extent and quality of their experience and fitness which are relevant to the duties of the position.

ORGANIZATION of a committee of physicians and laymen to aid Yale University in the development of its program in medicine and public health was announced by Dean S. Bayne-Jones, of the School of Medicine, at a meeting of medical alumni held in the Sterling Hall of Medicine on February 23. Dr. Harvey Cushing, Sterling professor of neurology emeritus and director of studies in the history of medicine, will act as general chairman, with an executive committee composed of Dean S. Bayne-Jones, *chairman;* Fuller F. Barnes, Bristol, Conn.; William McCormick Blair, Chicago; George Parmly Day, Yale University; Thomas W. Farnam, Yale University; Dr. Norman E. Freeman, Philadelphia; Harry C. Knight, New Haven; Dr. Fred T. Murphy, Detroit; Professor C.-E. A. Winslow, Yale University, and Dr. Milton C. Winternitz, Yale University. The purpose of the committee is to aid in making better known among the alumni and friends of the university the work of Yale in medicine and public health. For the development of this work, large sums, contingent upon the receipt of further gifts, have already been pledged.

MEMBERS of a state soil conservation committee authorized at the last special session of the California State Legislature have been appointed as follows: Dean Claude B. Hutchison, of the College of Agriculture; Professor B. H. Crocheron, director of the Agricultural Extension Service, University of California, and Edward Hyatt, state engineer. Walter W. Weir, university drainage engineer, has been made secretary. It is understood that the membership of the university men on the committee is purely advisory, and that the actual administration and operation of the act will remain in the hands of the state officials. The committee is empowered to promote the formation of soil conservation districts, to investigate proposed soil conservation districts, to advise with such districts, to cooperate with the appropriate federal authorities and with individuals and corporations interested in soil conservation and to coordinate the activities of the various agencies interested in soil conservation.

THE ninth semi-annual Eastern Photoelasticity Conference will be held at Cornell University on May 13. The committee on local arrangements, of which Professor F. G. Switzer, of the College of Engineering at Cornell, is chairman, expects an attendance of approximately one hundred scientific workers in this field, both from college faculties and from the research staffs of various industries. The program of technical papers will be supplemented by an exhibit of the latest equipment for photoelastic research and demonstrations in the laboratories. A special program is being prepared for the wives of those who attend the conference.

DISCUSSION

WILLIAM BREWSTER: NEW ENGLAND NATURALIST

THE natural history of New England can not be found in any one book, and in many ways I am glad that it is so. For I think I shall always want to go to "Moby Dick" for cetacean lore; to "Walden" for such natural philosophy as may be educed from bean-fields, ponds and winter animals; to Frank Bolles's stanzas for vivid glimpses of Chocorua's wild tenants; to Forbush's "Birds of Massachusetts" for precise ornithology; and to other works equally unique.

There are some classic accounts of New England's nature that date back to colonial times. For an early first-hand record of the now extinct heath-hen of Martha's Vineyard, one may go to Thomas Morton's "New English Canaan" (1637), and to John Josselyn's "New England's Rarities Discovered" (1672) for an authoritative glimpse of that noble bird, the wild turkey, which for us has become an emblematic part of colonial New England, but which disappeared from Connecticut in 1813, from Vermont about 1842 and from Massachusetts in 1851.

New England, indeed, has had its share of illustrious naturalists. Perhaps one thinks first of Thoreau, the Concord hermit, and then of the great teacher and scientist, Louis Agassiz, who, though not a native son, was for many years (beginning in 1848) associated with Harvard College, and it was he who established a museum of zoological research at Harvard, now the Museum of Comparative Zoology.

Years later there worked at this same museum a man in whom was happily combined the indoor and the outdoor naturalist. His name was William Brewster, and he was one of the greatest of American ornithologists. He was a Yankee birdman unique in at least one respect: "No ornithologist has ever lived in America who could compare with Brewster as a master of simple, dignified English prose"—this on the authority of Dr. Thomas Barbour, the present director of Harvard's Museum.

During his lifetime Brewster was little known outside of his own profession. But it happened that during a great part of his life, which extended from 1851 to 1919, he kept voluminous diaries, which were full of bird lore and of Concord River lore, and out of these diaries have come three books, published posthumously, that are bringing Brewster's genius to the attention of the general reader to parallel the high esteem in which ornithologists have held him for many years. His technical bibliography is a long one, but I believe he would have been particularly gratified at the way his three last volumes have been received. His friend Daniel Chester French, the sculptor, remarked that Brewster "always regretted that he could not write popular articles on natural history as did some of his contemporaries."

"The Birds of the Lake Umbagog Region of Maine" is the first of these works to be mentioned. It is a 620-page volume, issued in four parts as a *Bulletin* of the Museum of Comparative Zoology: the first in June, 1924, the second in February, 1925, the third in November, 1937, and the fourth (compiled by Ludlow Griscom) in February, 1938. It represents field observations and collecting of birds around Lake Umbagog over a period of 38 years, beginning in 1871, when Brewster was only 20 years of age. It is all original work; there is scarcely a quotation in it. A great deal of it is supplemented by extracts from his detailed journals and notebooks written at the time the field work was in progress. But even in these there is no slipshod writing, and in every line there is evidence of the carefullest scientific observation but recorded in a way that betrays William Brewster's great love of nature and all its manifestations. It is straightforward and without sensationalism. On August 24, 1874, for example, he writes:

> Wearing a purple-and-yellow cardigan jacket, recently obtained from a country store in Upton, I was fishing this morning at a pool of Cambridge River, just below the Sluice, when a Hummingbird hovered for a moment within a few inches of the aforesaid garment, doubtless attracted by its gaudy coloring and probably suspecting that it might prove to be a bank of unfamiliar flowers. Precisely the same thing happened in another place several days ago. The bird did not fly away on either occasion until I startled it by moving slightly.

In 1891 Brewster bought an old farm of about 300 acres of woodland near Concord, about a mile and a half northwest of where the river bends around Balls Hill. This was in the old stamping grounds of Thoreau, and it was here that Brewster spent a great deal of his time studying the wild creatures and setting down the intimate details of their lives as he saw them first-hand. He fixed up the old farmhouse and named his sanctuary "October Farm."

And it was this expressive name, "October Farm," that became the title of the first volume of extracts from his Concord journals and diaries published in 1936 by the Harvard University Press and edited by his friend the late Rev. Smith Owen Dexter, of Concord. An introduction to the volume by Daniel Chester French, with whom Brewster grew up, is a real tribute, depicting the peculiar charm of William Brewster the man. Unpretentious and unheralded by publisher's

ballyhoo, the book was enthusiastically received by nature lovers and by many who had never heard before of its author. It went into a second edition, and an index was added. I believe it was advertised chiefly by word of mouth, the ideal way for news of a good book to spread.

Last year (1937) the Harvard Press followed "October Farm" with another volume from the Brewster journals called "Concord River." This was illustrated by a dozen plates, some in color, by the artist Frank W. Benson, who also had been a friend of Brewster's. The American Institute of Graphic Arts selected "Concord River" as one of the "Fifty Books of the Year" in its 1938 exhibition of American bookmaking.

The great simplicity and genuineness of these books are almost unbelievable in this day and age. They are books of the earth, but not of man's world. The entry for April 16, 1912, the day after the *Titanic* sank, reads:

> I saw two Great Blue Herons flying over the Farm towards the northeast at an elevation of fully a *mile,* one following closely in the wake of the other. For the most part they flapped their wings steadily and ceaselessly but twice I saw one of them sail for the distance of a few rods on set wings.

The same day he noted a flock of 36 Canada geese flying so high that they appeared no larger than bluebirds. "Rarely have I witnessed anything of the kind so impressive." Instead of man's noisy doings, Brewster wrote of bird songs, the tracks of foxes, the beauty of snowstorms, woods smoke and his beloved river. Thomas Barbour refers to him as the "modest and peerless recorder" and "utterly impersonal." "He wrote with no 'mission' in mind but simply because he had a warm, irrepressible urge to observe nature and set forth what he had seen but not what he thought about it."

Brewster's standing as a scientist probably will rest on his many other works and technical papers on ornithology, but as New England's great outdoor naturalist it will depend largely on the diaries and journals he left, and a most generous sampling of them has been given to us in the three volumes here described.

The details of Brewster's life have been adequately recorded elsewhere,[1] and my purpose here is merely to remind naturalists everywhere of these new chapters that have been added to the rich body of New England's natural history. Perhaps I may be pardoned if I add here my sonnet called "William Brewster: Man of Concord," which appeared originally in the *Washington Post* as a "review" of the book "Concord River." I believe it tells in another way what manner of man he was and why New Englanders should be proud that he was theirs.

> There by the river's bend he had his place.
> New England hills and hollows, fields, and springs
> Belonged to him, and he had sight and space
> To see uncommonness in common things.
> Up and down the Concord, paddling his canoe,
> He sought out nature's secrets like a sleuth;
> The flutter of a bird was oft a clue
> To bring him beauty and to show him truth.
>
> For serving God his meed was great and good:
> He touched a trembling vireo; unheard
> He watched a fox's cunning in the wood;
> To him the robin's rapture was transferred.
> How many men like Brewster do you know,
> Who'd find it joy to let a weasel go?

Paul H. Oehser

U. S. National Museum

[1] Sketch by Henry W. Henshaw in *The Auk,* January, 1920; and biography by Dr. Witmer Stone in the Dictionary of American Biography.

THE FERMENTATION TEST FOR THIAMIN

Schultz, Atkin and Frey[1] refer to a note published in Science[2] from this laboratory and deny the implication that their fermentation test involves the *growth* of yeast. Such implication, if present in the note referred to, was erroneous. It is true, of course, that growth and fermentation can be dissociated (as has been done in the fermentation test), but on the other hand under many laboratory conditions they are closely related; so much so that the discovery of the *growth* essential "bios" by Ide[3] (Wildiers[4]) was based upon a *fermentation* test. The vitamin test of Bachman (1919) was likewise based upon fermentation (during growth). Substances which stimulate growth need not necessarily influence fermentation, but they often do so.

Our questioning of the specificity of the fermentation test for thiamin was based partly on experiments which may have involved cleavage products of the vitamin.[5] If this is so, it has been cleared up by the discoverers of the fermentation test.[6]

Other objections which are perhaps not crucial are based upon the fact that substances other than thiamin, notably pantothenic acid, and nicotinic acid (discovered to be an interference by the originators of the method),[7] have an influence. Duplicating the author's conditions as nearly as is possible using the Warburg technic, we have found that pantothenic acid, by stimu-

[1] A. S. Schultz, L. Atkin and C. N. Frey, Science, 88: 547, 1938.
[2] R. J. Williams, Science, 86: 349, 1937.
[3] R. J. Williams, Science, 88: 475, 1938.
[4] E. Wildiers, ''La Cellule,'' xviii, 313, 1901.
[5] R. J. Williams and R. R. Roehm, *Jour. Biol. Chem.,* 87: 581, 1930.
[6] A. S. Schultz, L. Atkin and C. N. Frey, *Jour. Amer. Chem. Soc.,* 60: 3084, 1938.
[7] A. S. Schultz, L. Atkin and C. N. Frey, *Jour. Amer. Chem. Soc.,* 60: 1514, 1937.

lating fermentation in the presence of thiamin, may increase the carbon dioxide production 10 per cent. If deficient yeast (grown on a medium which is nearly synthetic in character) is used, the effect of pantothenic acid on fermentation (without growth) is even much greater than that of thiamin. Under these conditions, which are admittedly not those prescribed by the authors of the test, β-alanine and ethanolamine also have definite stimulative effects.

Stimulation of yeast fermentation by liver extract (Lilly's 343) is vastly greater under the conditions prescribed than can be obtained by any amount of added thiamin. Under these conditions growth accompanies the fermentation. If conditions which permit growth are carefully avoided, this difficulty is minimized.

On the basis of further developments and recent work by the originators we are now more favorably inclined to the fermentation test for thiamin than formerly. Though subject to certain errors, we believe that as amended it may serve as a very useful tool.

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ERNEST F. PRATT

OREGON STATE COLLEGE

THE INFLUENCE OF SOME DIGESTIVE FERMENTS ON THE EXPERIMENTAL CROWN-GALL

IN our experiments we tried to repeat some of the very interesting experiments described by Ark.[1] That author has found that digestive ferments such as pepsin, papain and some other organic compounds had a very marked influence on the plant tumors caused by *Pseudomonas tumefaciens.*

For these experiments we chose 30 different crown-galls on Pelargonium inoculated with *P. tumefaciens,* strain "Bela" from the Lister Institute in London. Eleven tumors were treated with papain and eleven with pepsin. Eight were kept as controls. These enzymes were applied in powdered form and were placed in long narrow incisions where small sections of tumors had been cut away. From all control tumors similar sections of tissue were taken away. Then the galls were wrapped in Cellophane.

Six out of eleven tumors treated with pepsin deteriorated, one month after treatment. Five were left without any or only slight injury. Out of eleven tumors treated with papain three died off and nine were left partly or entirely intact. From the eight control tumors four died off in the same time as treated ones.

Therefore, our findings are not in complete agreement with those of Ark. We came to the conclusion that the enzymes like papain and pepsin are not always effective in the treatment of crown-gall. In some cases at least the mechanical injury of crown-gall may effect a total necrosis of the tumors.

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[1] P. A. Ark, SCIENCE, 85: 364.

ALEPRIC AND ALEPRYLIC ACIDS, NEW HOMOLOGS OF CHAULMOOGRIC ACID

IN analyzing *Hydnocarpus wightiana* oil by the method described by us[1] the high optical activity and iodine numbers of the lower boiling fractions of ethyl esters indicated that there must be present at least one more optically active fatty acid besides those already known (chaulmoogric, hydnocarpic and gorlic[2] acids). By repeated vacuum fractional distillation of 100 liters of *H. wightiana* ethyl esters and fractional crystallization of the free acids we have finally succeeded in isolating two new homologs of chaulmoogric acid. There is still a third homolog present which we hope to obtain pure, but being a liquid acid, it is much more difficult to purify.

Because of their relationship to the therapy of leprosy we have named these two new acids alepric acid and aleprylic acid. Alepric acid is the next lower homolog to hydnocarpic acid, containing two carbon atoms and four hydrogen atoms less than the latter. The acid is solid at room temperature, melts sharply at 48° C. and has a high specific optical rotation (+77°). The melted acid, upon solidifying, forms characteristic, beautiful branching crystals rising high above the surface of the melt, similar to those already reported by us for pure chaulmoogric and hydnocarpic acids.[3]

Aleprylic acid is the next lower homolog to alepric acid, differing from it by C_2H_4. It crystallizes in the same characteristic manner as the other homologs. It melts sharply at 32° C. and has a very high specific optical rotation (+90°).

The bactericidal properties of these acids against *M. leprae* as compared with those of chaulmoogric, hydnocarpic and gorlic acids are now being determined.

The methods of separating these new acids with more detailed data concerning them and their ethyl esters will form the subject of a paper to be published elsewhere.

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[1] H. I. Cole and H. T. Cardoso, *Jour. Am. Chem. Soc.,* 60: 614, 1938.
[2] *Ibid.,* 60: 612, 1938.
[3] *Ibid.,* 59: 963, 1937.

SOCIETIES AND MEETINGS

THE SOCIETY OF THE SIGMA XI

THE thirty-ninth annual convention of the Society of the Sigma Xi met at 4:00 P.M. on Wednesday, December 28, in the Hotel Jefferson in Richmond, Virginia, with forty-six chapters and thirteen clubs represented by delegations of from one to three members.

In his annual report as president of the society, Professor Baitsell announced fourteen grants-in-aid totalling $3,000; the assignment of five lecturers to forty institutions all over the country; and the society's first published volume, entitled "Science in Progress," to be issued by the Yale University Press in the spring, containing the ten Sigma Xi lectures sponsored by the society in the last two years.

Four new chapters have been added to the organization during the year—Rice Institute, Wellesley College, Massachusetts State College and the University of Florida. This brings the total of chapters to seventy-six, with an active enrolment of approximately 16,000.

The treasurer's report showed permanent funds amounting to approximately $40,000, an annual expenditure of $18,000 met from current income and a surplus of income over disbursements of approximately $3,000 for 1938.

Charters for chapters were granted to the University of West Virginia and the University of Alabama.

Dr. Carl D. Anderson, of the California Institute of Technology, was elected a member of the executive committee for the ensuing five-year term to succeed Professor L. J. Stadler, whose term of office has expired. Dr. Florence Sabin, of the Rockefeller Institute, was elected a member of the Alumni Committee for the ensuing five-year term to succeed Mr. Harold Norton, whose term has expired.

A committee was appointed to study the present membership structure of Sigma Xi for report at the next convention.

An amendment to the constitution was adopted, providing for the revocation of a charter of a chapter when, and if, circumstances should demand such action.

The seventeenth annual Sigma Xi lecture, under the joint auspices of the American Association for the Advancement of Science and of Sigma Xi, was given in the Mosque by Dr. W. F. Durand on "Modern Trends in Air Transport."

EDWARD ELLERY

FINANCIAL REPORTS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT THE RICHMOND MEETING

AUDITED financial reports of the treasurer and the permanent secretary for the fiscal year ended September 30, 1938, were presented and approved by the council. The following is a brief digest:

TREASURER'S REPORT

Balance Sheet—Assets at September 30, 1938

Securities and mortgages	$255,265.36
Cash—income account	8,933.88
Cash—reserve for current needs	15,998.90
Total assets	$280,198.14

Balance Sheet—Liabilities at September 30, 1938

Endowment—for research (1)	$114,236.45
Endowment—for general purposes (2)	92,738.38
Endowment—dues of emeritus life members (3)	9,100.00
Endowment—dues of emeritus annual members (4)	500.00
Reserve fund	35,582.41
Permanent secretary's fund	12,042.00
Annual $1,000 prize fund	4,000.00
Unused grants to affiliated academies, etc.	775.00
Accumulated income unappropriated	11,223.90
Total liabilities	$280,198.14

(1) Richard T. Colburn fund, $87,186.45; A. G. Stillhamer fund, $3,500; fees of deceased sustaining members, $7,000; fees of deceased life members, $16,550.

(2) W. Hudson Stephens fund, $4,381.21; Michael P. Rich fund, $10,000; Hector E. Maiben fund, $31,448.17; Friends of the Association, $3,559; fees of living life members, $43,350.

(3) Jane M. Smith fund, $5,000; credits to fund from fees of $100 each set up from income from the fund or from general fund reverting on deaths of emeritus life members.

(4) Luella A. Owen fund.

CASH STATEMENT

Receipts

Balance, September 30, 1937	$ 19,321.71
Newcomb Cleveland gift to Grants Committee	1,000.00
Life membership fees	1,100.00
Revertment of grants	128.31
Donation to prize fund	2,000.00
Income from research fund	3,959.88
Income from general fund	3,421.47
Income from reserve fund	1,249.18
Income from permanent secretary's current funds	422.75
Income from Jane M. Smith fund	312.90
Income from Luella A. Owen fund	18.19
Total receipts	$ 32,934.39

Disbursements

Grants for aid of research	$ 2,725.00
Grants to affiliated academies	2,035.00
Annual prize—to Philip R. White	1,000.00
For emeritus life members	300.00
For emeritus annual members	15.00
Life members' journal subscriptions	1,599.00
Fifty-year members' journal subscriptions	87.00
Maiben lecture—R. C. Wallace	200.00
Safe deposit box and collection charges	40.61
Total disbursements	$ 8,001.61
Cash on hand, September 30, 1938	24,932.78
Total	$ 32,934.39

PERMANENT SECRETARY'S REPORT

(Period October 1, 1937, to September 30, 1938)

Receipts

Annual membership dues and fees	$ 88,600.85
Life membership fees	1,100.00
Contributions from members	3,337.50
Grant from Carnegie Corporation of New York	4,000.00
On grant ($5,000) from General Education Board	2,500.00
Sales of publications	1,804.55
Miscellaneous receipts	2,698.10
Special journal subscriptions	2,436.00
Registration fees—Indianapolis meeting	2,819.00
Registration fees—Ottawa meeting	1,107.00
Receipts from exhibitors—Indianapolis meeting	5,304.50
Advance receipts from exhibitors—Richmond meeting	866.75
Total receipts	$116,574.25
Cash in banks, September 30, 1938	1,652.70
Reserve in Treasurer's hands	11,619.70
Total	$129,846.65

Disbursements

Subscriptions to journals, including foreign postage	$ 55,020.68
Allowance to Pacific and Southwestern Divisions	2,358.00
Expenses of Washington office	23,879.56
Expenses of General Secretary	329.48
Expenses of Treasurer	200.00
Circularizing for new members	6,536.47
General and travel expenses—Indianapolis meeting	3,741.03
Expenses of exhibition—Indianapolis meeting	3,563.00
Expenses of press service—Indianapolis meeting	603.96
General and travel expenses—Ottawa meeting	2,959.44
Expenses of press service—Ottawa meeting	316.63
Preliminary expenses—Richmond meeting	1,028.96
Preliminary expenses—Milwaukee meeting	75.00
Preliminary expenses—Columbus meeting	40.00
Printing symposia	2,590.26
Life membership fees to Treasurer	1,100.00
Miscellaneous expenses	2,304.52
Expenses of Committee on Improvement of Science in General Education	1,314.56
Preparing and mailing radio broadcasts	3,878.87
Special journal subscriptions	2,454.00
Total expenditures	$114,294.42
Cash in banks	3,509.78
Cash in Treasurer's hands	12,042.45
Total	$129,846.65

REPORTS

DROPLET FISSION OF URANIUM AND THORIUM NUCLEI

THE fifth Washington Conference on Theoretical Physics, sponsored jointly by George Washington University and the Carnegie Institution of Washington, began January 26, 1939, with a discussion by Professor Bohr and Professor Fermi of the remarkable chemical identification by Hahn and Strassmann in Berlin of radioactive barium in uranium which had been bombarded by neutrons. Professors Bohr and Rosenfeld had brought from Copenhagen the interpretation by Frisch and Meitner that the nuclear "surface-tension" fails to hold together the "droplet" of mass 239, with a resulting division of the nucleus into two roughly equal parts. Frisch and Meitner had also suggested the experimental test of this hypothesis by a search for the expected recoil-particles of energies well above 100,000,000 electron-volts which should result from such a process. The whole matter was quite unexpected news to all present.

We immediately undertook to look for these extremely energetic particles, and at the conclusion of the conference on January 28 were privileged to demonstrate them to Professors Bohr and Fermi. It was subsequently learned that the particles had been observed independently by Fowler and Dodson at the Johns Hopkins University on the same day, by Dunning and coworkers at Columbia University on January 25 and by Frisch in Copenhagen two weeks earlier.

The experiments made in our Atomic-Physics Observatory at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington are no doubt typical of similar experiments done at the other laboratories, but details of this work are not available to us. The experimental work here was done chiefly by my colleagues, R. B. Roberts, R. C. Meyer, L. R. Hafstad and N. P. Heydenburg.

For observations of the high-energy particles, an ionization-chamber, about five mm deep, was placed about three cm below the neutron-source and was so arranged that interchangeable copper disks about three cm in diameter could be placed on the collector, which was connected to a linear pulse-amplifier. The upper faces of these disks were then coated with the materials to be tested.

With the amplifier feeding a cathode-ray oscillograph the usual alpha-particle pulses were observed when a layer of uranium oxide was placed on the disk. On exposure to neutron-radiation from (Li + D) at 1,000 kv two additional groups of pulses were observed. The first group corresponded to the "neutron-recoils" from the air in the chamber, as previously measured with the same amplifier gain and without the uranium. These neutron-recoils gave pulses about four times the size of the alpha-particle pulses. The second additional group was 20 to 40 times larger than the largest "recoil"-pulse, thus coresponding to energies of 75 to 150 Mev released in the chamber, or 150 to 300 Mev total energy for each individual process. With paraffin surrounding source and chamber the yield was roughly 30 counts per min per μ A of 1,000-kv deuterons, which is a neutron-intensity corresponding to about 10,000 millicuries of radon-beryllium.

The yield from thorium was of the same order of magnitude.

No effect was observed from bismuth, lead, thallium, mercury, gold, platinum, tungsten, tin or silver with as much as 1/1000 the intensity of that from uranium and thorium.

No effect was observed with either uranium or thorium produced by the gamma rays from 3 μ A of 1,000-kv protons on lithium or on fluorine.

To determine roughly the energy-range of the neutrons involved in the fission-process, observations were made with the neutrons from several reactions, both with and without cadmium surrounding the ionization-chamber to filter out the thermal neutrons produced in the surrounding paraffin. Bearing in mind that the ratio of the counts with cadmium and without cadmium depends to a large extent on the amount of paraffin surrounding the source and chamber, the results of these tests may be deduced from Table 1 in which the relative number of "fissions" is given, with the total yield for

uranium and thorium with high-energy neutrons, being approximately equal, taken as 100 on an arbitrary scale.

Neutron-reaction	Maximum neutron-energy	Uranium		Thorium	
		No Cd	With Cd	No Cd	With Cd
	Mev				
Li+D ..	13.5	100	70	100	100
D+D ..	2.5	100	70	100	100
C+D ..	0.5	100	10	0	0

From these comparisons it apears that the uranium fissions are produced by different processes for fast and slow neutrons, the fast-neutron process requiring more than 0.5 Mev but less than 2.5 Mev for effective operation. For thorium, on the other hand, only the fast-neutron process is effective, but somewhat surprisingly it also appears to require between 0.5 and 2.5 Mev.

A few words with regard to our present knowledge on the efficiency of these processes may be in order. The capture of a neutron with the energy of one thirtieth of an electron-volt gives rise to the release of 200,000,000 electron-volts of energy, but the production of a single slow neutron requires the expenditure of approximately 3,000,000,000 electron-volts of energy by the bombarding beam in the most efficient process yet known (deuterons on beryllium at 9,000,000 volts).

It may also be of interest to record that the measurements on this extremely interesting new process in uranium and thorium were the first experiments carried out with our new 5,000,000-volt equipment for nuclear physics, aside from nuclear measurements performed for voltage-calibration only. We take pleasure in recording our obligation to Dr. John A. Fleming, director of the department, for his vigorous support of our program in fundamental physics.

M. A. TUVE

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SPECIAL ARTICLES

POSSIBLE AVITAMINOSIS K PRODUCED IN MICE BY DIETARY MEANS

RECENT work on the possible relation of a deficiency of the fat-soluble factor, vitamin K, to the bleeding tendency in obstructive jaundice,[1] and loss of coagulability of blood in bile fistula dogs[2] and bile fistula rats[3] suggests that an avitaminosis K might be produced in mammals by dietary means alone. However, as far as the present writer is aware, a hemorrhagic disease in mammals comparable to that in chicks[4,5,6] has not as yet been produced. Consequently, this brief report is being made of a bleeding tendency occurring in mice maintained on a diet low in vitamin K and prevented by supplementation with the vitamin in the form of an ether extract of alfalfa.

In connection with a series of experiments concerned with the nature of the raw egg-white syndrome as produced in mice, it was apparent that when the tails were clipped in order to obtain blood bleeding continued for a longer time than is normally expected. Comparison of the clotting time with that of mice on a stock diet of Dog Chow showed that it took approximately twice as long for the blood of the experimental animals to coagulate as it did for the stock mice.

The diet that was used to produce the syndrome was made up as follows: powdered egg albumin (Merck), 61 per cent.; cornstarch, 27 per cent.; brewer's yeast, 5 per cent.; salt mixture, 4 per cent.; cod liver oil, 2 per cent.; agar, 1 per cent. This diet is relatively low in fat and might, therefore, be expected to contain only a limited amount of the fat-soluble factor. In addition, the albumin which makes up a large proportion of the diet has been reported to lack vitamin K[7] and yeast has been found to contain little or none of this factor.[8] To determine whether a vitamin K deficiency did exist, bleeding time was determined by Duke's method, using the clipped tails of three groups of mice: (1) stock mice on Dog Chow, (2) mice on the basal diet described above, and (3) mice on the basal diet supplemented with an ether extract of alfalfa equivalent to 5 per cent. of the diet. The tests were done after the animals had been on the diets for four to five weeks. Typical results are given in Table I.

TABLE I

Diet	Number of mice	Average bleeding time, minutes
Dog Chow	8	4.6
Basal	17	10.8
Basal plus extract of alfalfa	14	4.9

[1] E. D. Warner, K. M. Brinkhous and H. P. Smith, *Proc. Soc. Exper. Biol. and Med.*, 37: 628, 1938.

[2] W. B. Hawkins and K. M. Brinkhous, *Jour. Exper. Med.*, 63: 795, 1936.

[3] J. D. Greaves and C. L. A. Schmidt, *Proc. Soc. Exper. Biol. and Med.*, 37: 43, 1937.

[4] H. Dam, *Biochem. Jour.*, 29: 1273, 1935.

[5] H. J. Almquist and E. L. R. Stokstad, *Jour. Biol. Chem.*, 111: 105, 1935.

[6] F. Schonheyder, *Nature*, 135: 653, 1935. Since this paper was submitted for publication it has been noted that H. Dam and J. Glavind (*Lancet*, 1: 720, 1938) referred to their unpublished experiments in which this condition was produced in rabbits and cured by vitamin K. They gave no details concerning the type of diet used nor the symptomatic picture that resulted.

[7] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 12: 329, 1936.

[8] H. J. Almquist, C. F. Pentler and E. Mecchi, *Proc. Soc. Exper. Biol. and Med.*, 38: 336, 1938.

It should be noted that one of the symptoms of the raw egg-white syndrome in mice is the excretion of large amounts of bile salts and bile pigments in the urine. However, the icteric condition is not responsible for the defect in bleeding, since the administration of vitamin K ameliorated the latter without decreasing elimination of the bile constituents.

While the results are not so striking as those reported for chicks, the constancy of the bleeding defect on the basal diet and its prevention by supplements of alfalfa extract suggest that a vitamin K deficiency has been produced. No more definite conclusion can be drawn until measurements of the prothrombin concentration of the blood have been made.

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THE SODIUM FACTOR OF THE ADRENAL[1]

IN our study of the adrenal factor, which causes retention of sodium in normal animals, we discovered that it could be separated from the vital factor, cortin, by repeated extractions with ethyl ether. The cortin content of our extracts was assayed on adrenalectomized cats,[2] while the presence of the sodium factor was determined by the effect on sodium retention in normal dogs.[3] In the latter instance injections were made subcutaneously in order to avoid the development of the refractory state.[4] A six-hour test period was employed.

We have made many preparations with high cortin content but no sodium-retaining power. For example, six different preparations, injected in amounts containing 20 to 80 cat units of cortin, caused no retention of sodium. On the other hand, extracts in which no separation of cortin and sodium factors had been made (which will be called whole extracts) gave very positive results. Seven different preparations injected in amounts containing 30 to 60 cat units of cortin caused a sodium retention of 37 to 54 per cent.

Extracts have also been prepared containing large amounts of the sodium factor but very little cortin, as illustrated in Table I.

TABLE I

Extract	Cortin content Cat units	Sodium retention Percentage
N	3	47
O	0	32
P	2	61
Q	1+	70
R	0	50
S	5	55

The effects of these two factors have been studied on adrenalectomized animals. Two adrenalectomized male cats were treated with cortin alone for 130 days. The results were similar in each, the plasma sodium being maintained at the level characteristic of untreated adrenalectomized animals in the advanced state of insufficiency. The animals remained in good condition, showing no significant change in weight (Table II). Reduction of the cortin to the point of insufficiency produced little change in plasma sodium, while addition of the sodium factor to the cortin treatment caused a rise in plasma sodium to normal levels. Treatment with whole extract (cortin and sodium factor not separated) had a similar effect. The inability of the sodium factor to maintain adrenalectomized cats was demonstrated in the assay for cortin content of such extracts (Table I).

The effect of these factors has also been studied on two adrenalectomized female dogs, of which Dog 19 (Table II) is typical. When whole extract was injected the plasma sodium was maintained at normal levels, while treatment with cortin alone caused it to fall to approximately the level characteristic of adrenal insufficiency. As in the cats, the animals remained in good condition with cortin alone. Addition of the sodium factor to the cortin treatment caused a rise in plasma sodium to normal level.

TABLE II

Days after complete adrenalectomy	Weight Kgm.	Extract	Plasma Sodium mEq./1
		Cat ES	
61	3.70	Cortin alone, enough for maintenance	143.0
110	3.70	Cortin alone, decreased to point of insufficiency	141.0
130	3.66	Cortin alone, maintenance dosage	142.0
137	3.66	Cortin plus sodium factor	151.5
167	3.74	Whole extract	149.8
		Dog 19	
146		Whole extract	140.3
173	8.0	Whole extract	143.0
225	8.0	Cortin alone	130.5
243	8.0	Cortin alone	132.3
250	8.0	Cortin plus sodium factor	143.8

Our evidence indicates that there is a separate adrenal hormone responsible for sodium retention. In the absence of this hormone cortin maintains the adrenalectomized animal in spite of the diminished plasma sodium.

FRANK A. HARTMAN
HERBERT J. SPOOR
LENA A. LEWIS

1 Aided by a grant from the Rockefeller Foundation.
2 F. A. Hartman and W. D. Pohle, *Endocrinology*, 20: 795–800. 1936.
3 G. A. Harrop and G. W. Thorn, *Jour. Exper. Med.*, 65: 757. 1937.
4 F. A. Hartman, L. A. Lewis and K. P. McConnell, *Endocrinology*. (In press.)

IMMUNIZATION TO INFECTIOUS MYXOMATOSIS

Infectious myxomatosis (Sanarelli) is known to be a highly specific and an almost invariably fatal virus disease for the domestic rabbit. More than 2,000 rabbits from our inbred colony have been tested with this virus under laboratory conditions in various experiments over a period of ten years. Every normal animal has proved susceptible, not a single one has escaped a fatal issue. Death follows in from 8 to 11 days after proper exposure to the active agent. It was demonstrated by Shope that the rabbit could be protected against this disease by previous treatment with the fibroma virus. We have confirmed and extended this observation. The fibroma virus, by all portals of entry, usually confers a solid and lasting immunity to the otherwise fatal myxoma.

Attempts to immunize the host with the myxoma virus attenuated by heat or chemicals have in the hands of a number of workers proven ineffective. It is in fact the usual experience of all workers with the viruses that little if any immunity results with the use of heat-inactivated virus.

We have found that some resistance to myxoma can be conferred upon the rabbit by previous intradermal injections of heat-inactivated tissue virus (60 C.°–30′). This refractory state may be enhanced by the addition of the viable type III *pneumococcus* or *Bact. lepiseptícum* to the heated tissue vaccine, but not by the addition of the vaccine virus or viable tumor cells (Walker's rat carcinoma 256).

That the phenomenon is one of immunity is indicated by the fact that rabbits so treated give a marked allergic response to intradermal injections of the myxoma virus. The disease in many cases is aborted or its course mitigated. The skin lesions are more restricted and circumscribed. Discrete tumor-like nodular formations, instead of spreading oedematous lesions, appear on the ears and eyelids as well as on other parts of the body. Death is delayed. Many animals survive, some fully recover, others show chronic asthmatic symptoms with conjunctivitis. Animals that survive are solidly immune to massive intradermal injections of the myxoma virus except for the local response at the site of injection. Antibodies are present to an appreciable titer as determined by complement fixation. In general the titer of the serum of the treated animals at the time of infection is an index of their degree of resistance. The results suggest that accessory agents may be useful in attempts to establish immunity in other virus diseases where our efforts with heat-inactivated virus have thus far failed. Details of these experiments will be given in a forthcoming series of papers.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION OF THE SET-UP FOR WICK CULTURE

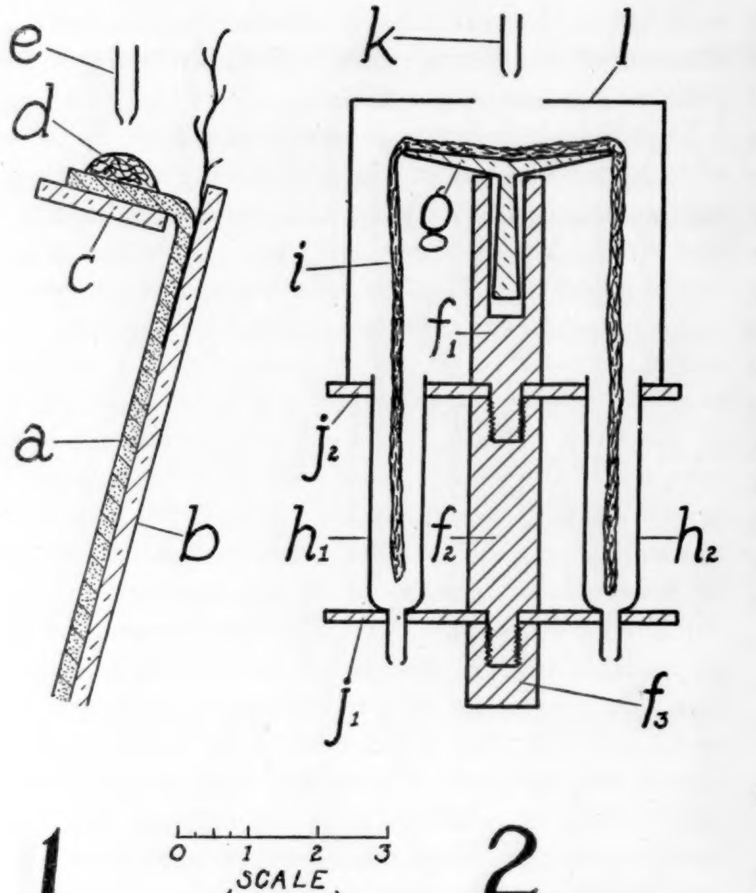
In the set-up for growing plants by the wick-culture method as previously described by the writer[1] the main wick (the sheet of absorbent material on the surface of which the plant roots develop) is supplied with solution by means of a number of secondary wicks dipping into the solution contained in a pan situated near the upper edge of the main wick. Regulation of solution supply is accomplished by varying the number and width of these secondary wicks as well as the solution level in the pan.

While this method has been used with entire satisfaction by the writer, it has been found almost prohibitively difficult by other workers in this laboratory. Recourse has been had, therefore, to dripping the solution onto the upper edge of the main wick. The modified set-up for this purpose is illustrated diagrammatically in Fig. 1, in which (*a*) indicates the main wick; (*b*) the sheet of plate glass against which it rests; (*c*) is a piece of plate glass about 10 cm wide which is supported in a position perpendicular to (*b*) near its upper edge, and at a distance of 1 to 1.5 cm from it, on which the upper edge of the main wick (*a*) rests. The solution dripping from the tube (*e*) falls on a wad (*d*) of absorbent cotton or glass wool placed along the upper edge of the main wick and serving to distribute the solution laterally across its width. We have found dripping the solution on at two points along its width entirely satisfactory for a main wick of a width of 45–60 cm.

A Wick Arrangement for Subdivision of the Solution Stream

A slow drip of solution of constant rate is readily obtainable by the use of either a capillary resistance device such as described by Trelease and Livingston,[2] by Shive and Stahl[3] and by Zinzadze[4]; or a small-volume metering pump such as has recently been devised by the writer (shortly to be described). For subdivision of the solution stream (for dripping on at several points of the upper edge of the main wick) the wick arrangement illustrated diagrammatically in Fig. 2 has proved very satisfactory. It will be noted that the device contains no moving parts and no small orifices, and that the solution passing through it need not come into contact with any material other than glass.

[1] *Am. Jour. Bot.*, 24: 185–187, 1937.



FIGS. 1 and 2 (the scale applies only to Fig. 2.)

Referring to the figure, (f_1), (f_2) and (f_3) are sections of brass rod which screw together to form a single central column. At the two points of junction of the sections are mounted the circular brackets (j_1) and (j_2), in which are holes for holding the funnel tubes (h_1) and (h_2). On the top of the brass column is mounted a shallow glass dish (g)—made from the inverted foot of a wine glass or sherbet glass, with the stem suspended in a deep recess bored in the top of the column. A wick (i), consisting of a strip of glass cloth or tape,[5] is placed with its central portion resting in the shallow glass dish (g) and its ends suspended in the funnel tubes (h_1) and (h_2). (l) is a glass cover for maintaining the humidity around the upper portion of the wick (i). It is made from a small battery jar, inverted, with a hole bored in the bottom for the inflow tube (k). The apparatus is mounted by means of burette clamps (not shown) on the half-inch rod of a laboratory stand.

In operation of the device, the incoming solution stream, dripping from the inflow tube (k) onto the central portion of the wick (i), is subdivided by the capillary action of this into two outgoing streams dripping from the ends suspended in the funnel tubes (h_1) and (h_2). From these the solution flows to the wick-culture apparatus below. If the two portions of the wick are closely equal in width and length, then the solution streams dripping from them will also be found to be closely equal (readily within 5 per cent., which is adequate for the purpose in hand). Simultaneous subdivision into four streams has been accomplished without difficulty in this manner.

With regard to the mode of operation of the device, it may be interesting to note that there is a tendency to a pulsation or rhythm in its action. Liquid tends to accumulate in the shallow glass dish, and then to drain out through the ends of the wick. It would seem therefore that, at least in part, the mode of action of the device is that of an intermittent siphon with multiple outlet tubes.

M. A. RAINES

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[2] SCIENCE, 55: 483–486, 1922.
[3] *Bot. Gaz.*, 84: 317–323, 1927.
[4] SCIENCE, 81: 540–542, 1935.
[5] Cloths and tapes woven from spun glass may be obtained from the Fibre Products Division of the Corning Glass Works, Corning, N. Y.

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WENTWORTH, CHESTER K. *Ash Formations of the Island Hawaii;* Third Special Report of the Hawaiian Volcano Observatory of Hawaii National Park and the Hawaiian Volcano Research Association, 1938. Pp. viii + 183. Illustrated. The Association, Honolulu.